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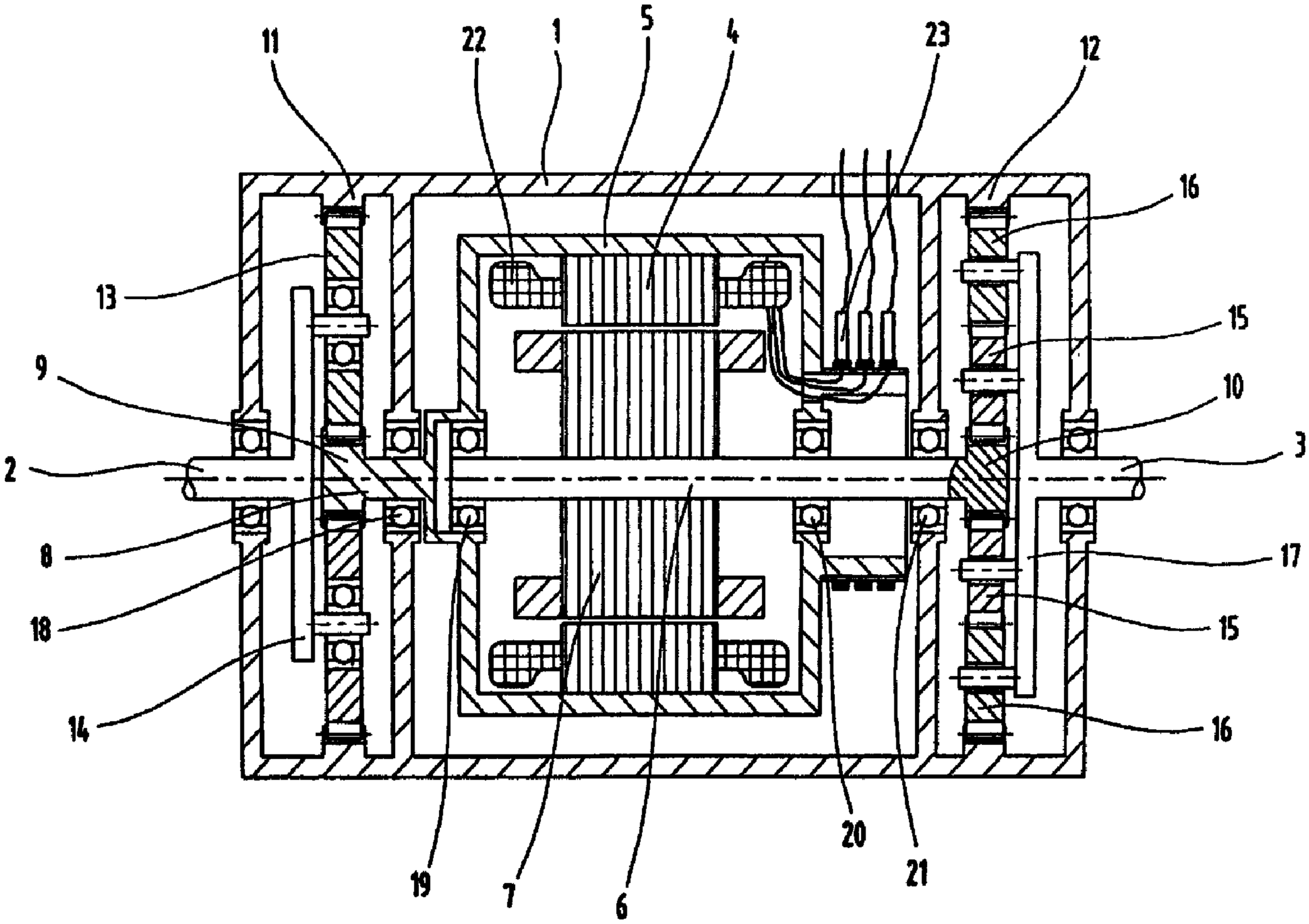
(54) Title: ELECTRIC DRIVE FOR A VEHICLE




(57) Abrégé/Abstract:
The invention relates to an electric drive for a vehicle. A housing (1) that is stationary in relation to the vehicle frame is provided. A motor housing (5) having a stator (4) and a rotor (7) being provided in said motor housing (5) are rotationally mounted in said

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(57) Abrégé(suite)/Abstract(continued):
housing. The motor housing (5) and the rotor (7) perform opposite rotational movements. A drive train (2) is connected to the motor housing (5) and the rotational movement of the motor housing (5) is carried out by means of a transmission device with the same drive and output direction of rotation. The remaining drive train is connected to the rotor (7) and the rotational movement of the rotor (7) is carried out by means of a transmission device with opposite drive and output direction of rotation. The transmission devices are planetary gears. The rotor (7) engages with the planet wheels (13 or 16) of the allocated planetary gear by means of a spur pinion (10) that is arranged on the shaft (6) or the motor housing (5) engages with the planet wheels (13 or 16) of the allocated planetary gear by means of a spur pinion (9) that is connected to the motor housing (5) and is arranged on the axis of the motor housing. A web (14 or 17) is provided. Said web is connected to the axles of the planet wheels (13 or 16) of each planetary gear and drives the wheel shaft assigned thereto.

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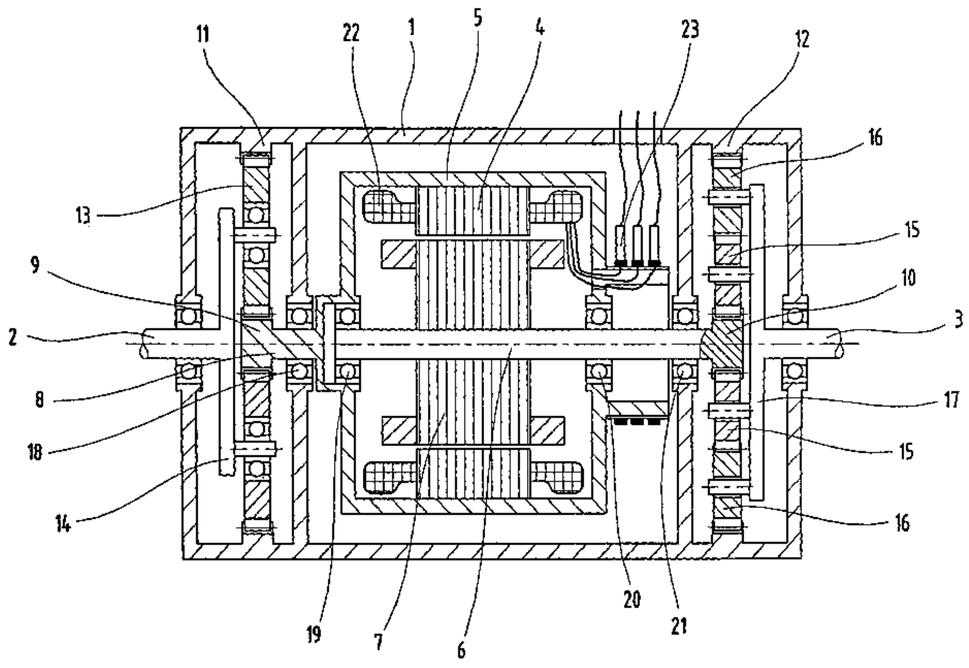
*[Fortsetzung auf der nächsten Seite]*

(54) Title: ELECTRIC DRIVE FOR A VEHICLE

(54) Bezeichnung: ELEKTRISCHE ANTRIEB FÜR EIN FAHRZEUG




(57) Abstract: The invention relates to an electric drive for a vehicle. A housing (1) that is stationary in relation to the vehicle frame is provided. A motor housing (5) having a stator (4) and a rotor (7) being provided in said motor housing (5) are rotationally mounted in said housing. The motor housing (5) and the rotor (7) perform opposite rotational movements. A drive train (2) is connected to the motor housing (5) and the rotational movement of the motor housing (5) is carried out by means of a transmission device with the same drive and output direction of rotation. The remaining drive train is connected to the rotor (7) and the rotational movement of the rotor (7) is carried out by means of a transmission device with opposite drive and output direction of rotation. The transmission devices are planetary gears. The rotor (7) engages with the planet wheels (13 or 16) of the allocated planetary gear by means of a spur pinion (10) that is arranged on the shaft (6) or the motor housing (5) engages with the planet wheels (13 or 16) of the allocated planetary gear by means of a spur pinion (9) that is connected to the motor housing (5) and is arranged on the axis of the motor housing. A web (14 or 17) is provided. Said web is connected to the axles of the planet wheels (13 or 16) of each planetary gear and drives the wheel shaft assigned thereto.

(57) Zusammenfassung: Der Erfindung betrifft einen elektrischen Antrieb für ein Fahrzeug, bei dem ein zum Fahrzeugrahmen feststehendes Gehäuse (1) vorgesehen ist, in dem ein Motorgehäuse (5) mit einem Ständer (4) und ein im Motorgehäuse (5) vorgesehener Läufer (7) jeweils drehbar gelagert sind. Das Motorgehäuse (5) und der Läufer (7) führen eine gegensinnige Drehbewegung aus. Ein Antriebsstrang (2) ist mit dem Motorgehäuse (5) verbunden und die Drehbewegung des Motorgehäuses

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**Veröffentlicht:**
— *mit internationalem Recherchenbericht*

*Zur Erklärung der Zweibuchstaben-Codes, und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.*

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(5) erfolgt über eine Getriebeeinrichtung mit gleichsinniger An- und Abtriebsdrehrichtung. Der andere Antriebsstrang ist mit dem Läufer (7) verbunden und die Drehbewegung des Läufer (7) erfolgt über eine Getriebeeinrichtung mit gegensinniger An- und Abtriebsdrehrichtung. Die Getriebeeinrichtungen sind Planetengetriebe. Der Läufer (7) steht über ein auf der Welle (6) angeordnetes Stirnrad (10) bzw. das Motorgehäuse (5) mit einem mit dem Motorgehäuse (5) verbundenen und auf der Motorgehäuseachse angeordneten Stirnrad (9) mit den Planetenrädern (13 bzw. 16) des zugeordneten Planetengetriebes in Eingriff. Es ist ein Steg (14 bzw. 17), der mit den Achsen der Planetenräder (13 bzw. 16) jedes Planetengetriebes verbunden ist, vorgesehen, der seine zugeordnete Radwelle antreibt.

# Electric Drive for a Vehicle

## Field of the Invention

The invention relates to an electric drive for vehicles.

## Related Art

US 516 917 A describes an electric drive that is used for driving two wheels independently, whereby one wheel is connected to the field winding so as to be stationary in relation to the winding, and the other wheel is connected to the rotor via a differential gear. In order to achieve an equal torque on both wheels the differential gear must, with the field winding and rotor running at the same speed, effect a reverse in the direction of rotation of the rotor only, without changing the speed. This is the case in the embodiments shown, on the one hand as a differential gear ring similar to the arrangement in known axle differentials, on the other hand as a spur pinion-planetary gear with the same function.

Furthermore, US 613 894 A describes a dynamo and electric drive for vehicles. In this embodiment with two electric components capable of coaxial rotation, the two components are connected to each other by a gear unit with high speed reducing ratio, and to a stationary part. In one embodiment, it is suggested that the housing of the rotating field winding should be connected to a drive wheel of the vehicle so as to be stationary in relation to the wheel. In a further embodiment, the internal shaft is to be used as a drive for slow-running machines.

Furthermore, a device with a rotating field winding is known, whereby current is supplied to the field winding via slip rings. The equally rotating rotor drives the housing of the field winding via a planetary gear with a high speed-increasing ratio. As in US 613 984 A, this unit is used preferably for slow-running machines, for example as a drum drive for winches, whereby the entire drive has room within the drum.

A drive train for an electric vehicle is also described in US 5.845.732 A. Thereby, one drive shaft is connected to a rotor that is arranged coaxially with the wheel shafts, whereby the rotor is mounted on a hollow shaft and drives the sun gear of a planetary gear. The web of this gear is connected to a wheel shaft that runs through the hollow rotor shaft. The ring gear of the gear is connected to the web of another planetary gear that is arranged coaxially with the rotor shaft. This gear has to effect a torque reversal so that the second wheel shaft, to which it is connected, rotates in the same direction as the first wheel shaft. The disadvantage of this embodiment is the need for a hollow shaft to accommodate the rotor.

US 5.487.438 A and EP 0 587 120 A3 describe a drive system for an electric vehicle. Within the scope of this drive system, an axle drive is shown in which the field winding, which is mounted so as to be capable of rotation and which is supplied via slip rings, is connected to the pinion of a gear unit. This pinion engages with a ring gear which in turn is connected to one of the wheel shafts so as to be stationary in relation to the shaft. In this gear unit, the pinion and the ring gear rotate in the same direction. The rotor, which is also mounted so as to be capable of rotation, drives a spur pinion that engages with another spur pinion that is connected to the other wheel shaft. This gear unit effects rotation of the wheel shaft in the opposite direction in relation to rotation of the rotor. The function of a differential gear is thus provided. With a suitable choice of gear wheel diameters, the wheel shafts can be aligned. The disadvantage of this embodiment is the fact that the field winding and the rotor rotate around an additional axle parallel to the wheel shafts, thus increasing the costs of construction of the housing. Furthermore, the intended high speed-increasing ratios require a large diameter for the ring gear of the gear unit, which reduces the ground clearance of vehicles with such an axle to a level that is not permissible.

US 5 804 935 A describes a drive system for electric vehicles.

This drive system is intended for vehicles with two driven axles, whereby a field winding that is mounted so as to be capable of rotation drives one wheel axle. With suitable devices, this drive train can be interrupted and the field winding can be fixed to the vehicle while the drive axle runs freely. Furthermore, a rotor is provided that drives the other drive axle. The current for the rotating field winding is provided via slip rings. The rotary movement of the rotor or field winding is transmitted directly to the connecting shaft to the drive axles. Under the condition that the rotor has the same rpm with reference to the stator, it is possible with the help of this device, with a fixed rotor and driving only one wheel axle, to achieve twice the driving speed as when driving both axles. In addition to the suitability of such a drive device only for vehicles with two driven wheel axles, a reduction gear must also be provided for each wheel axle in order to achieve a reasonable embodiment in terms of construction.

GB 2 008 862 A describes a double rotor with friction brakes.

A device is described in which both the field winding and the rotor are independently mounted on a joint axle so as to be capable of rotation and which can be fixed by means of friction brakes. Current is transmitted via slip rings. The rotational movement of the rotor and the field winding are superimposed in a suitable planetary gear unit. Downstream from this unit, there is a reduction gear for driving primarily a winch drum. By arresting the rotor or field windings, great differences in the rpm of the winch drum can be achieved, thus improving the handling of the relevant hoisting device or of a machine with similar specifications.

Furthermore, GB 2 254 965 A describes a gear system for vehicles driven by an electric motor. A device is proposed in which both the rotor and the field winding of a direct current unit are mounted on a mutual axle so as to be capable of rotation. Thereby, the rotor shaft is mounted on the vehicle so as to be capable of rotation at one end, and in the rotating housing of the field winding at the other end. The rotating housing of the field winding has a shaft

stump at one end that is mounted on the vehicle. At the other end, the housing is mounted on the rotor shaft. The operating current is transmitted by slip rings that are mounted on the outer diameter of the housing of the field winding. The rotor has a collector that is supplied via rotating brushes connected to the housing.

US 4 130 172 A describes an electric vehicle. In this disclosure, an electric motor drive system is described whereby the rotor and the field winding are arranged on a common axle so as to be able to rotate, whereby the direction of rotation of one of the output shafts is reversed with reference to the rotor movement by a bevel gear. The other output shaft is fixed rigidly to the rotation of the field winding. Since the described embodiment does not perform a reduction in rpm of the output shafts with reference to rotor and field coil, the drive wheels of the vehicle must be connected to the respective output shafts by means of a belt drive.

AT 405 924 B describes an electric drive for vehicles. This disclosure shows that the opposite direction of movement of rotor and field winding can be reduced to the wheel rpm either in the same or in opposite directions with a suitable planetary gear device, thus fulfilling the function of a gear drive with differential function. With the described gear units, rotor, field winding and wheel shafts can be arranged on one axis of rotation.

An axle drive for a vehicle is also known, whereby the rotor and the field winding are mounted so as to be capable of rotation and drive one wheel each. Both the main and the excitation current are supplied to the moving motor parts via an appropriately arranged slip ring transmission device. The necessary reduction to the rpm of the drive wheels is achieved with a two-step spur pinion unit for both the rotor and the field winding. An idler gear is inserted in one of these gears, thus achieving an opposite direction of rotation of the drive and output in this train. With a suitable choice of the spur pinions for this gear unit, it

is possible to have the wheel shafts and the rotor-field winding assembly on one common axle.

Furthermore, EP 0 867 324 A2 describes a vehicle, in particular a fork lift truck, that can be operated by an electric motor with stator and rotor rotating in opposite directions. In this disclosure, an axle drive device for floor conveyors is described whereby one wheel is driven by the rotating stator via a reduction gear and the other wheel is driven by the rotor via a spur pinion for reversal of direction as well as by a further reduction gear. With the functional separation between rpm reversal and reduction to wheel rpm, the cost of construction for two separate reduction gears is necessary in addition to the reversing mechanism.

Furthermore, US 3 267 311 A describes a combination of an electric motor and a differential drive for a vehicle. The axle drive for the vehicle consists of a rotating field winding that is connected rigidly to one wheel, and a rotor rotating on the same axle that is connected to the other wheel via a gear unit. The gear unit consists of a spur pinion connected to the rotor, which engages with idler gears. The axes of rotation of the idlers are fixed in relation to the housing and in turn engage with a ring gear that is arranged coaxially with the rotor axle. With this gear unit, a reversal of direction between rotor and wheel shaft is achieved. Since this gear also effects a speed reduction that is not negligible, the torques on the left and right wheel are necessarily different. Therefore and because of the lower speed reduction between the electric motor components and the drive wheels, the suitability of this combination for motor drives is questionable.

**Summary of the Invention**

The aim of this invention is to provide an electric drive that avoids the disadvantages of the above mentioned drives on the one hand, and that is easy to construct on the other hand.

The surprising advantage resulting from the features mentioned in the characteristics of Claim 1 must be seen primarily in the fact that a high speed increase for an electric motor is achieved in one gear step. According to the state of the art, such a high speed increase can normally be achieved only with a three-step spur pinion. Furthermore, the invention offers the benefit of an even torque distribution between the two wheel shafts. The reversing gear, where drive and output are arranged coaxially, makes a compact construction of the drive possible. In such a gear, the torque is transmitted by several sets of planet wheels for each gear. With the resulting optimal branching of output, a compact construction is possible.

A further advantage of the invention lies in the fact that by connecting the bridge to the wheel shafts the circumference speeds of the planetary wheels are lower and thus there are lower centrifugal forces.

With this drive according to the invention, a hollow shaft through the rotor with a complicated bearing mounting is not required to operate the opposite wheel shaft.

With the embodiment of the electric drive, high rotor and stator speeds can be achieved, resulting in a high output capacity.

It is possible to construct the entire gear unit to fit the diameter of the motor housing. This results in favourable assembly dimensions for production engineering, which in turn guarantees a good or high ground clearance with reference to the vehicle design.

It is possible to guarantee a simple construction allowing an economic production of the entire drive system.

It is possible to design a drive that is arranged between the left and right drive wheel, which provides the

differential function, and thereby requires so little space that a rigid coaxial connection between the wheel axles and the drive is possible without reducing the ground clearance of the vehicle to a level that is not permissible.

Another significant advantage of the drive system in accordance with the invention is the fact that when the vehicle is driving straight ahead the rotor rpm is approximately the same as the stator rpm. As is known, the sum of the speeds is important for the output capacity. The noise level, on the other hand, depends on the maximum rpm occurring in the system. The drive system according to the invention therefore achieves the output and thus the output capacity of twice the rpm with the noise of only once the rpm, thus offering a significant system advantage.

The speed can be increased to meet the required specifications optimally.

**Brief Description of the Drawings**

In the following, the invention is explained in more detail based on the embodiments illustrated in the figures.

The figures show:

Fig. 1: schematic illustration of the drive,

Fig. 2: schematic illustration of the drive, whereby the planet wheels are embodied as stepper gears,

Fig. 3: schematic illustration of the drive in accordance with a further embodiment,

Fig. 4: cross-section of an electric drive, and

Fig. 5: cross-section of a further embodiment of the electric drive.

**Detailed Description of the Preferred Embodiments**

By way of introduction, it is noted that in the various embodiments described the same parts are allocated the same reference numbers and the same component names, whereby the disclosures contained throughout the description can be applied by analogy to the same parts with the same reference numbers or same component names. Furthermore, position details given in the description, e.g. top, bottom, side, etc., relate to the figure being described and illustrated at the time and with a change of position should be transferred accordingly to the new position. Moreover, individual features or combinations of features from the different embodiments illustrated and described can represent independent inventive solutions or solutions according to the invention in themselves.

The problem forming the basis of the separate solutions according to the invention can be taken from the description.

As shown in Fig. 1, the electric drive consists of a housing 1 that is stationary with reference to the vehicle, from which a first drive train 2 and a second drive train 3 protrude on both sides. The torque for the first drive train 2 is applied by a stator 4 that is mounted in a motor housing 5, and the torque for the second drive train 3 is applied by a shaft 6 from a rotor 7 that is mounted on bearings so as to be capable of rotation. The motor housing 5 is fixed to a shaft stump 8 from the first drive train 2, whereby the shaft stump 8 has a spur pinion 9 at its free end. Equally, the shaft 6 has a spur pinion 10 at its free end. Between the drive trains 2, 3 and the spur pinions 9, 10, there is a gear unit each, embodied as a planetary gear.

Inside the stationary housing 1, within which the whole drive is integrated, a ring gear 11, 12 is arranged for each of the planetary gears. These ring gears 11, 12 could also be referred to as sun gears, since their axles are in the main axle of the drive. In the gear unit for drive train 2, the planet wheels 13 are engaged with the ring gear 11 and the spur pinion 9. A web 14 is connected to

the axles of the planet wheels 13, which drives the drive train 2 and subsequently the respective wheel shaft.

In order to achieve a reversal of direction for a drive used for a vehicle, idlers 15 are arranged in the gear unit for drive train 3, which is also embodied as a planetary gear, and these idlers 15 are meshed with the spur pinion 10 on the one hand and the planet wheels 16 on the other hand, whereby the planet wheels 16 engage with the ring gear 12. The axles of the idlers 15 and the axles of the planet wheels 16 are carried by a web 17, which drives the drive train 3 and subsequently the respective wheel shaft. Of course the planetary gear for drive train 2 could also have the idlers 15 and the planetary gear for drive train 3 could have planet wheels 16 that mesh directly with the ring gear 12 and the spur pinion 10.

Fig. 2 shows a schematic illustration of a gear unit for a drive system, whereby the basic structure of the drive is the same as the drive in accordance with Fig. 1. In this drive, the planetary gear for drive train 2 has planet wheels 13 that are embodied as stepper gears. Equally, the idlers 15 of the corresponding gear unit are embodied as stepper gears. With such a gear embodiment, it is possible to increase the speed-increase ratio.

Fig. 3 again shows a drive with the same basic configuration as the drive in Fig. 1. Thereby, the planet wheels 16 for the drive train 3 could be embodied as stepper gears, whereby the idlers 15 are of a conventional embodiment. With a suitable choice of tooth ratios for the planetary gears, the torque in the wheel shafts allocated to the drive trains can be defined, whereby the rotational movement of the wheel shafts is completely independent.

In accordance with Fig. 4, the electric drive has a fixed housing 1 whereby the freely rotating motor housing 5, in which the stator 4 of the electric motor is mounted, is supported above the shaft stump 8 by means of roller bearings 18. The shaft stump 8, which is fixed to the motor housing 5, has a spur pinion 9. In

the motor housing 5, the rotor 7 with its shaft 6 is supported on bearings 19 or 20. The spur pinion 10 is provided at one end of the shaft 6. The shaft 6 can also be supported in the fixed housing 1 by further rolling bearings 21.

The field winding 22 is arranged in the housing 1, which is mounted so as to be capable of rotation. Also, a number of slip contacts 23 are connected to the housing 1, through which the field winding 22 is supplied with electric current. The spur pinion 9 is engaged with planetary gear allocated to drive train 2. This planetary gear consists of one ring gear 11, which is fixed to the housing 1, and with which several planet wheels 13 engage that in turn engage with the spur pinion 9. The axles on which the planet wheels 13 are supported are fixed to the web 14, which drives one of the two wheel shafts of the vehicle via the drive train 2.

The rotor 7, which can be embodied as a short-circuit rotor or with permanent magnets, is connected via the shaft 6 to the spur pinion 10, which drives a further planetary gear. This consists of the ring gear 12 connected to the housing 1, several planet wheels 16, idlers 15 and the web 17, which supports the axles of the planet wheels 16 and the idlers 15. The ring gear 12 engages with the planet wheels 16. The idlers engage with the spur pinion 10 and the planet wheels 16. With this arrangement, a reversal of rotation between the shaft 6 of the rotor 7 and the corresponding other wheel shaft is achieved in addition to the necessary speed reduction. With a suitable choice of tooth ratios for the planetary gears, a similar or equal torque can be achieved at both drive trains 2, 3 and subsequently at the wheel shafts, whereby the rotation of the wheel shafts is completely independent.

Of course the arrangement of the gear units could also be switched without any loss of function.

With the gear arrangement shown in Fig. 5, a further increase in the speed-increase ratio can be achieved. The basic structure of the drive is equivalent to

the drive shown in Fig. 4. The planet wheels 13 and idlers 15 shown in Fig. 4 are embodied as stepper gears 24 and 25 in Fig. 5. Otherwise, the function is exactly the same.

Here, too, it is possible to reverse the gear units.

For form's sake, it is noted that for a better understanding of the structure of the device, the device and its components are illustrated partly untrue to scale and/or are enlarged and/or made smaller.

What is claimed is:

1. Electric drive for a vehicle, in particular for a multi-track electric motor vehicle, whereby a housing (1) that is stationary in relation to a vehicle chassis or frame is provided, and whereby a motor housing (5) with a stator (4) and a rotor (7), which are rotationally mounted within this motor housing (5), is provided in this housing (1), and whereby the motor housing (5) and the rotor (7) perform opposite rotational movements for output, whereby a drive train (2 or 3) is connected to the rotor (7) or to the motor housing (5) and the rotational movement of the rotor (7) or the motor housing (5) is carried out by means of a transmission device with the same drive and output direction of rotation, and whereby the remaining drive train (2 or 3) is connected to the motor housing (5) or the rotor (7) and the rotational movement of the motor housing (5) or rotor (7) is carried out by means of a transmission device with opposite drive and output direction of rotation and the transmission units are planetary gears, characterised by the fact that the rotor (7) engages with the planet wheels (13 or 16) of an allocated planetary gear by means of a spur pinion (10) that is arranged on a shaft (6) or the motor housing (5) engages with the planet wheels (13 or 16) of the allocated planetary gear by means of a spur pinion (9) that is connected to the motor housing (5) and is arranged on an axis of the motor housing, and that a web (14 or 17) is provided that is connected to axles of the planet wheels (13 or 16) of each planetary gear and drives the wheel shaft assigned thereto.

2. Electric drive in accordance with Claims 1, characterised by the fact that the planet wheels (13, 16) and/or idlers (15) of at least one planetary gear are embodied as stepper gears (24, 25).

Fig.3

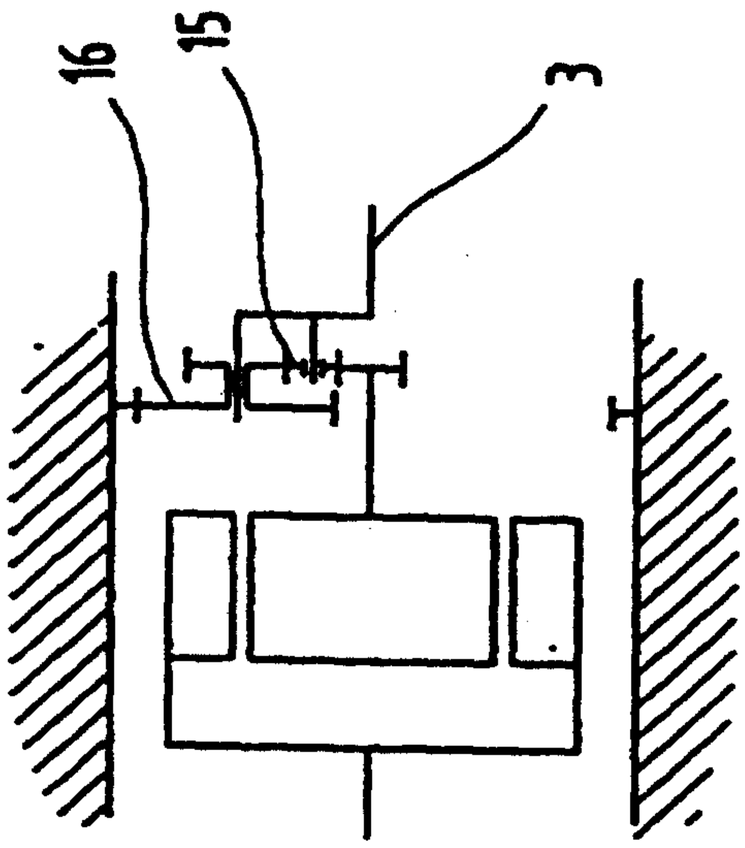



Fig.2

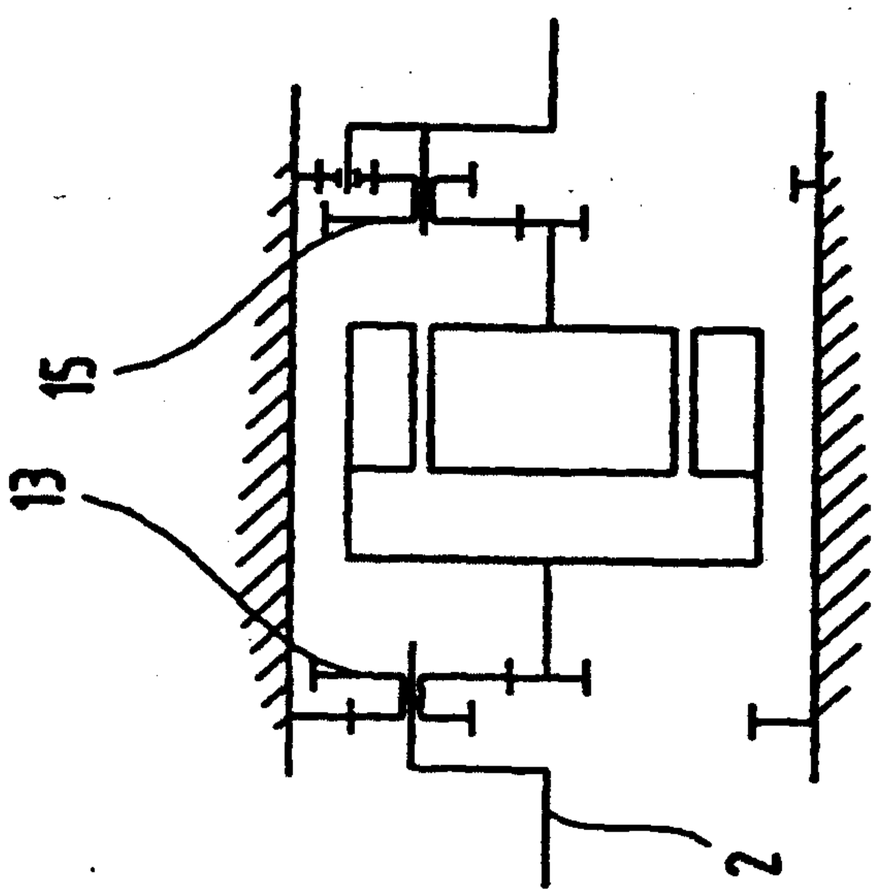
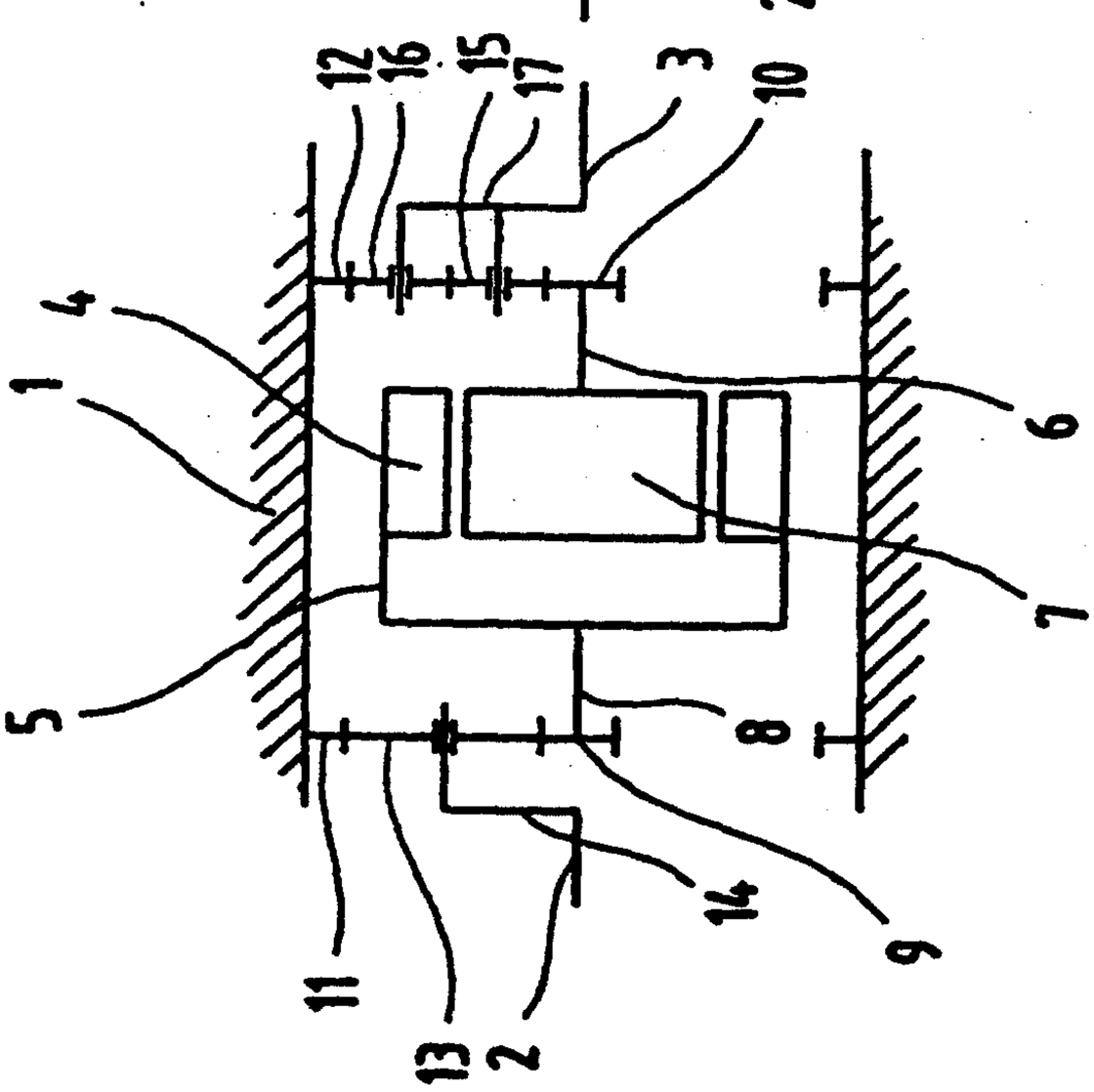



Fig.1



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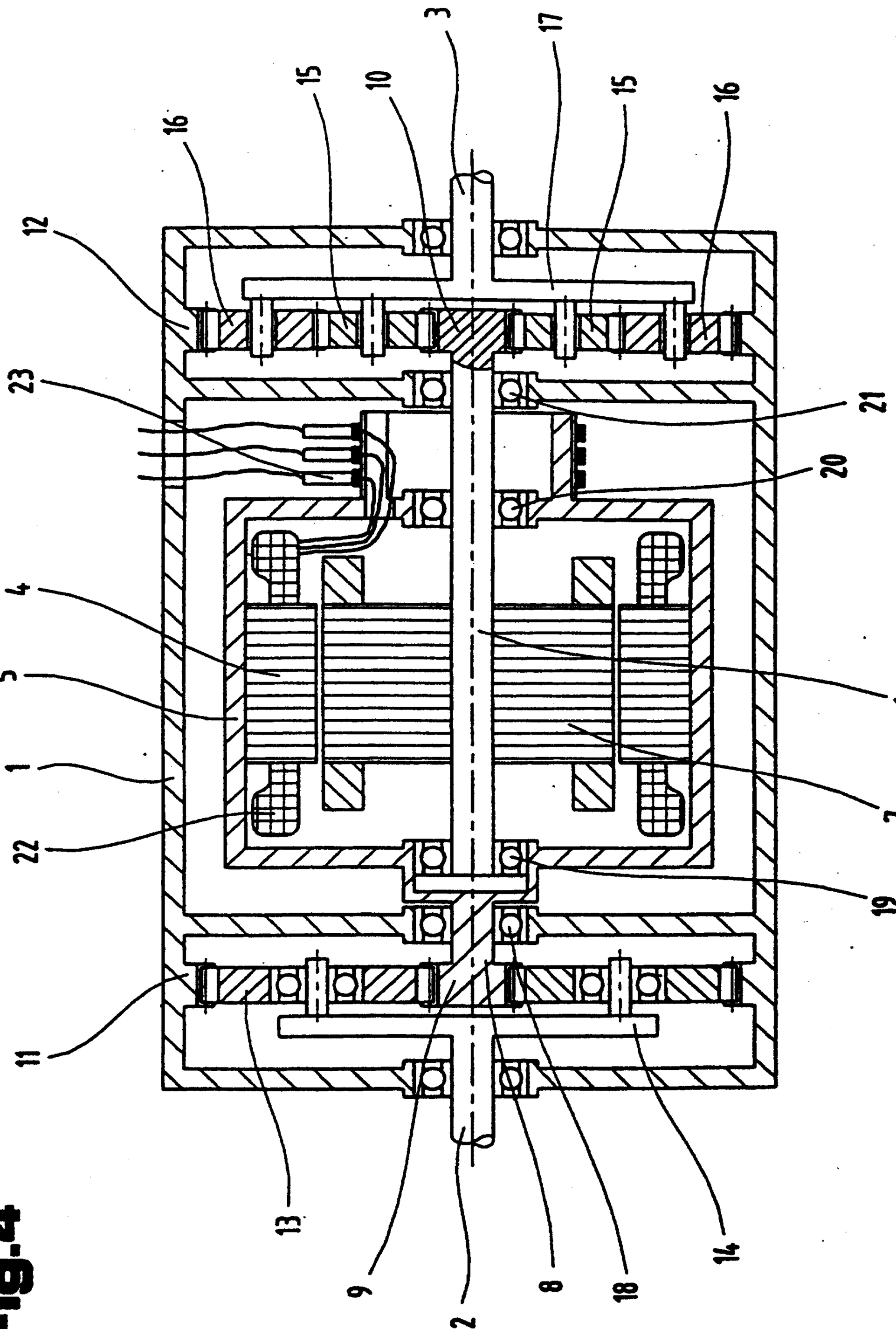


Fig.4

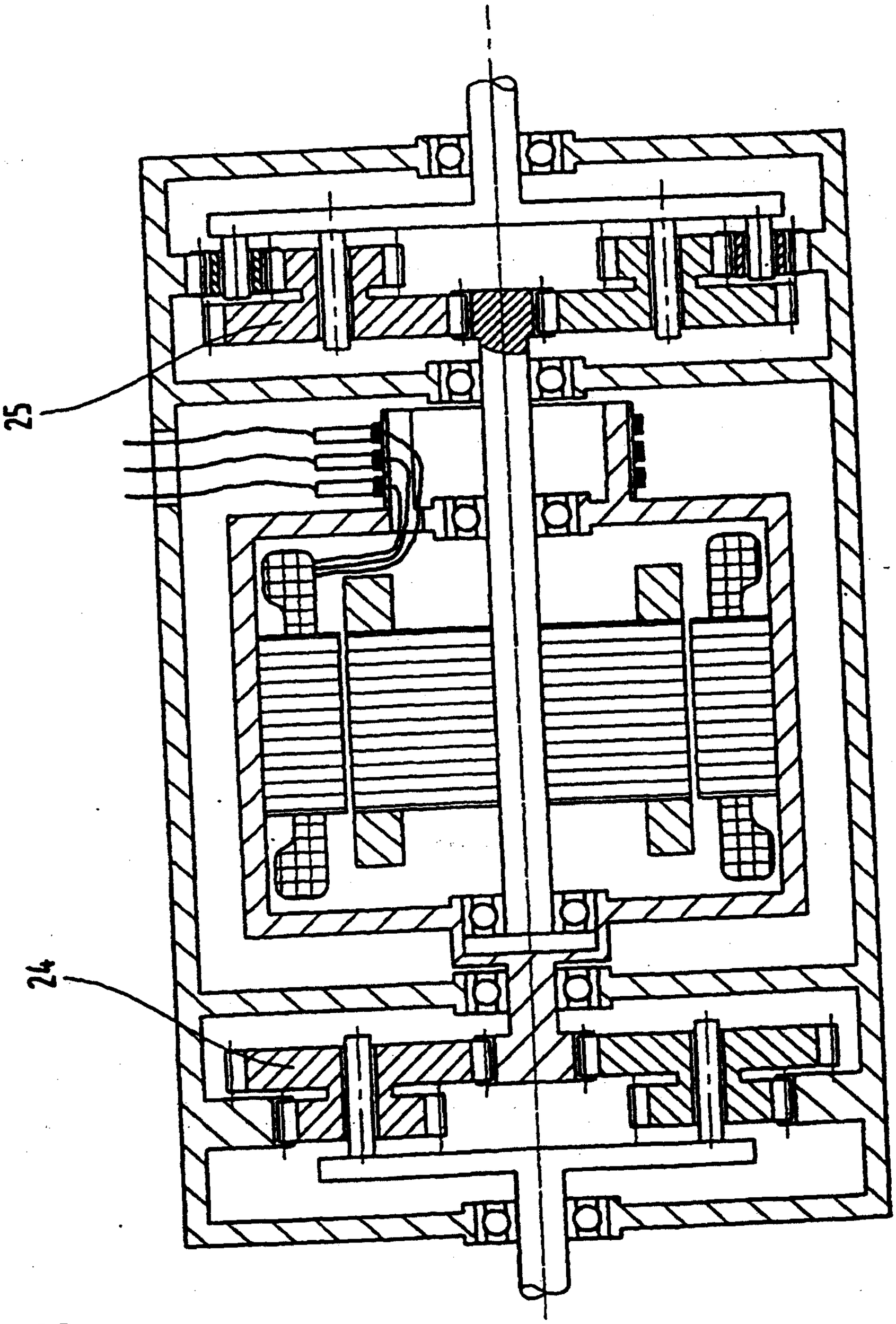


Fig.5



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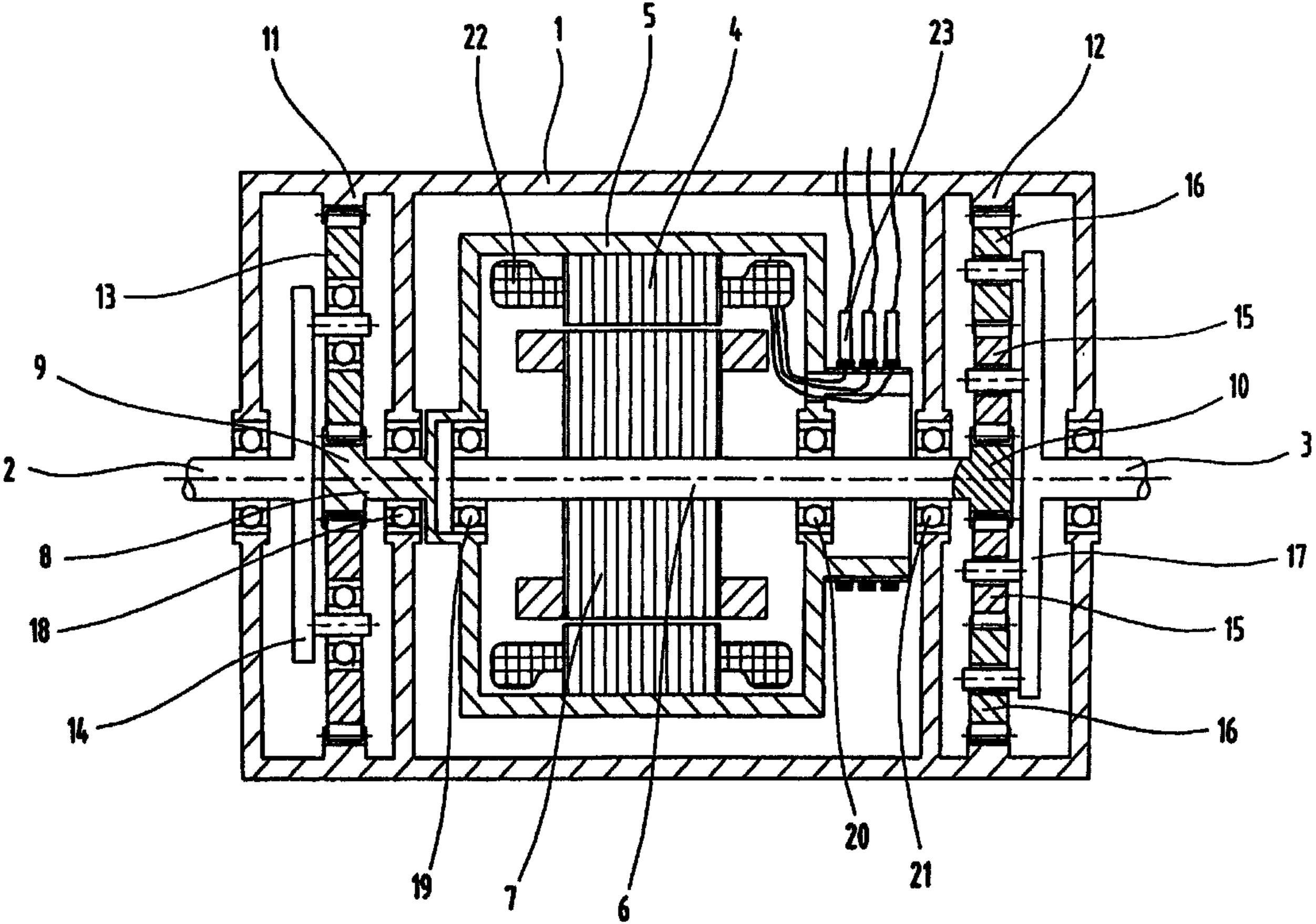
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